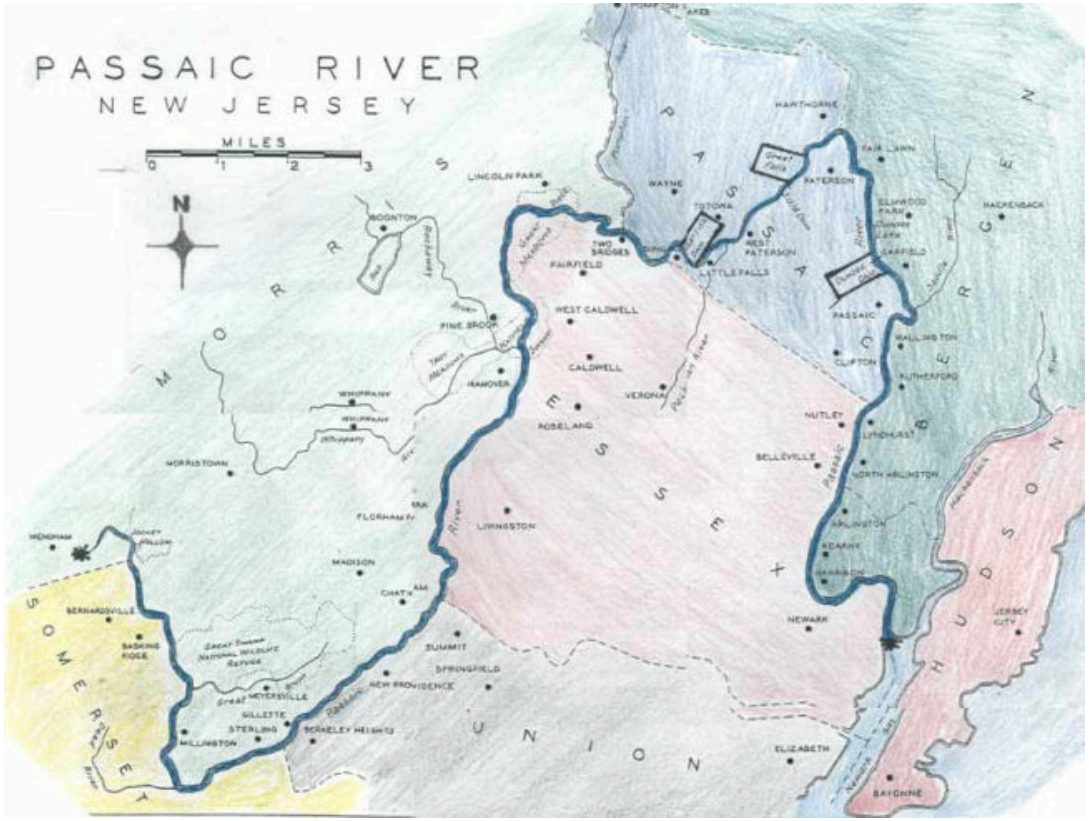
Welcome to The 2016 Series of CoPC Mapping Discussions



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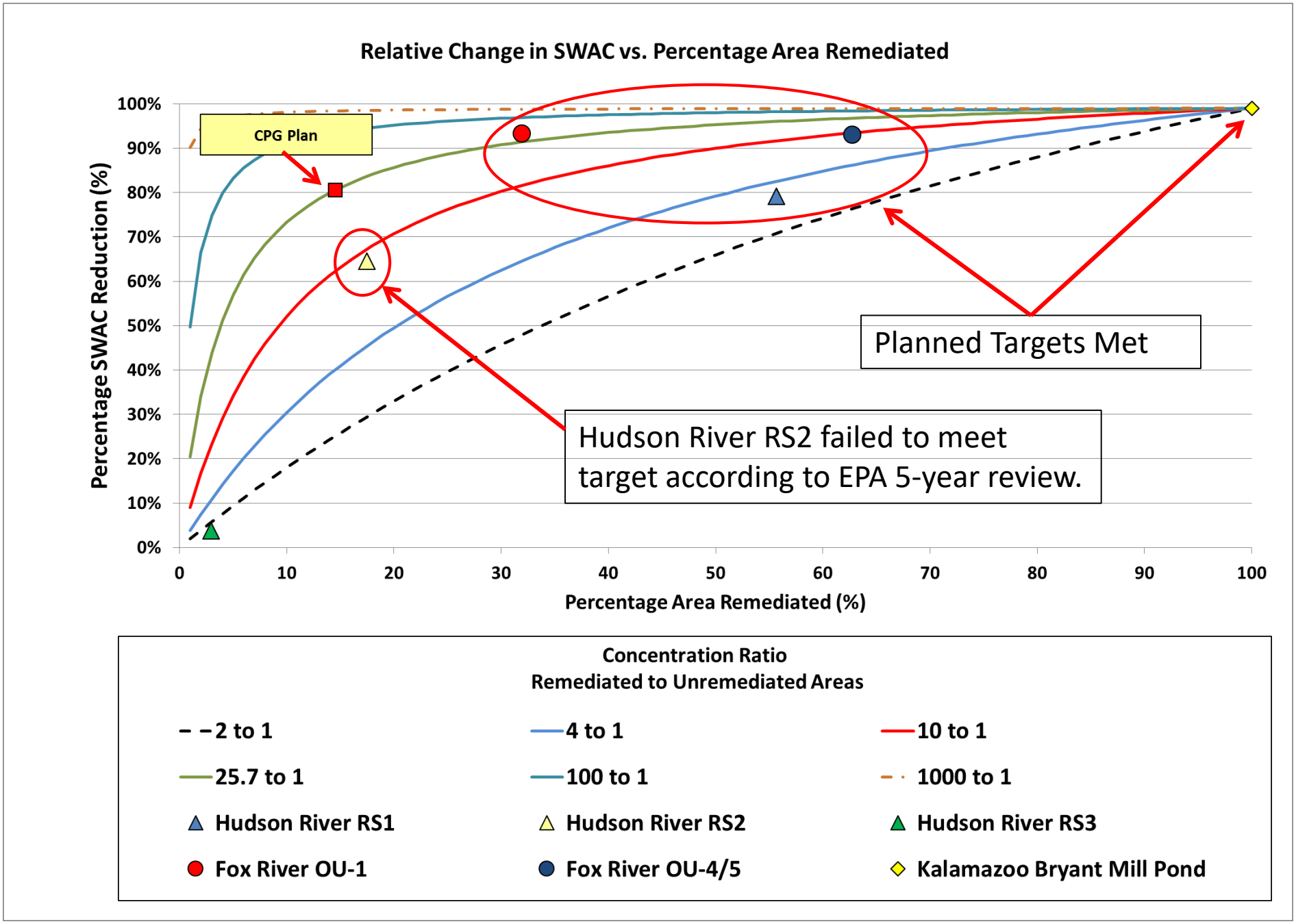
Technical Situation

CPG has proposed a calculation linking post remedial SWAC with RAL that is dependent on mapped concentrations based Thiessen polygons.

(SWAC reduction =81%; RAL=500 Remedial Footprint =15% of surface area)

- Based on multiple lines of evidence EPA concluded that for a selected RAL
  - Percentage SWAC reduction is overstated
  - Size of the remedial footprint is understated
- The seriousness of these errors decreases with decreasing PRG
  - With a PRG of 10 the bias is unimportant
  - With a PRG of 150 remedial footprint size may be understated by a factor of 2 or more
- Calculation has implicit assumption
  - Concentrations in all targeted sediments exceed the RAL, and
  - Concentrations in all nontarget sediments are less than the RAL
- CPG maintains position
  - Mapping and calculations are accurate
  - Supported by EPA precedent
  - Predesign sampling will correct any problems


Relative Change in SWAC vs. Percentage Area Remediated
Percentage SWAC Reduction (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
10
20
30
40
50
60
70
80
90
100
Percentage Area Remediated (%)
CPG Plan
Planned Targets Met
Hudson River RS2 failed to meet target according to EPA 5-year review.
Concentration Ratio
Remediated to Unremediated Areas
2 to 1
4 to 1
10 to 1
25.7 to 1
100 to 1
1000 to 1
Hudson River RS1
Hudson River RS2
Hudson River RS3
Fox River OU-1
Fox River OU-4/5
Kalamazoo Bryant Mill Pond

Alternatives for Consideration

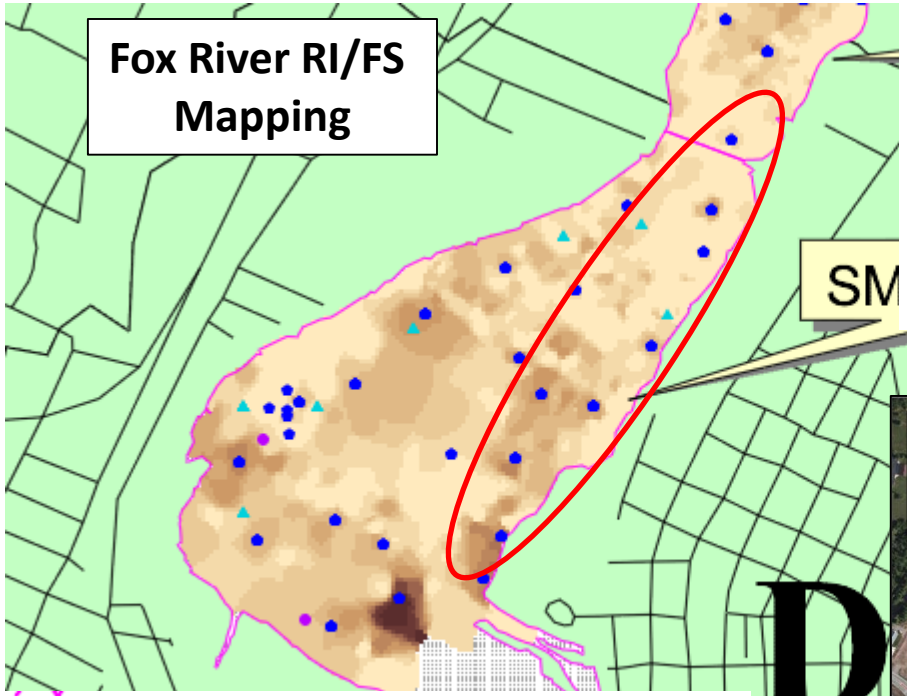
Continue with technical arguments

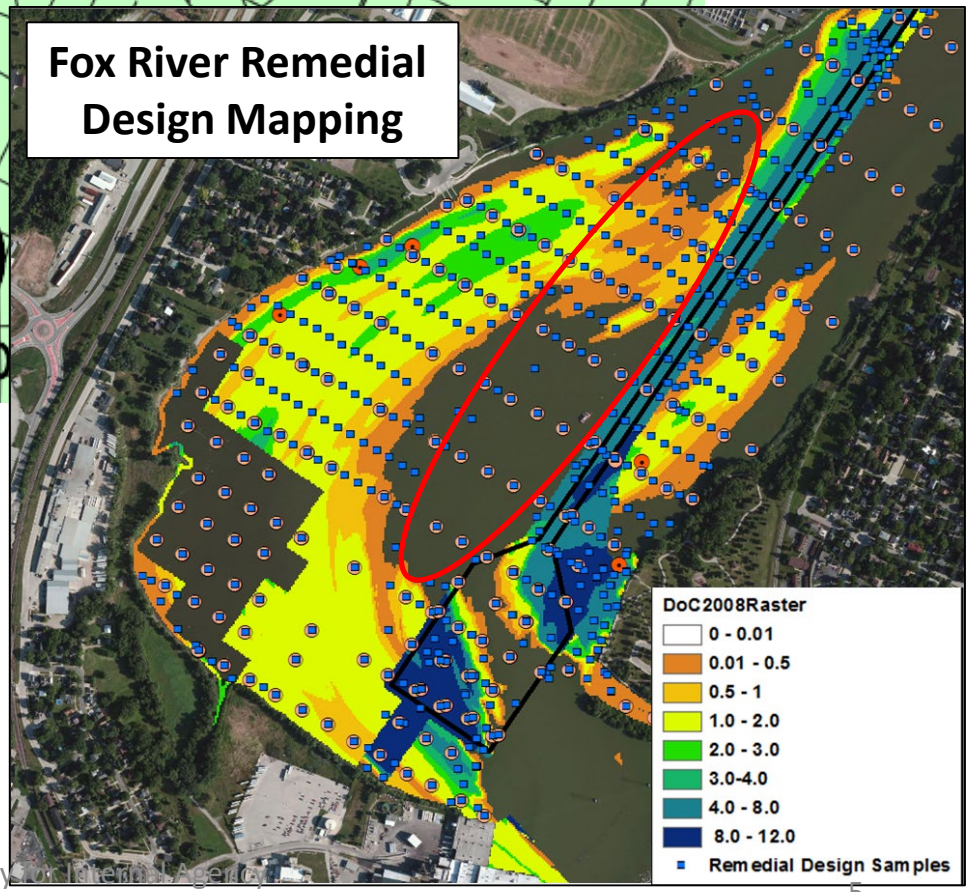
- Unlikely to be persuasive
- Likely to result in more delay
- Resolve public perception issues related to acceptance of methods EPA does not endorse.
- Should reduce delays and cost overruns during construction.
- Still need robust pre-design or confirmation sampling plan.

Move on and focus on robust pre-design sampling approach

- Reduce delays in RI/FS schedule
- Focus on development of a spatially extensive sampling plan protective against false negative errors
- Potentially have to anticipate schedule delays in design and construction as accuracy of RI/FS is realized.
- How to accept FS methods without increasing precedent
- Public perception

Example Pre-design Sampling Fox River





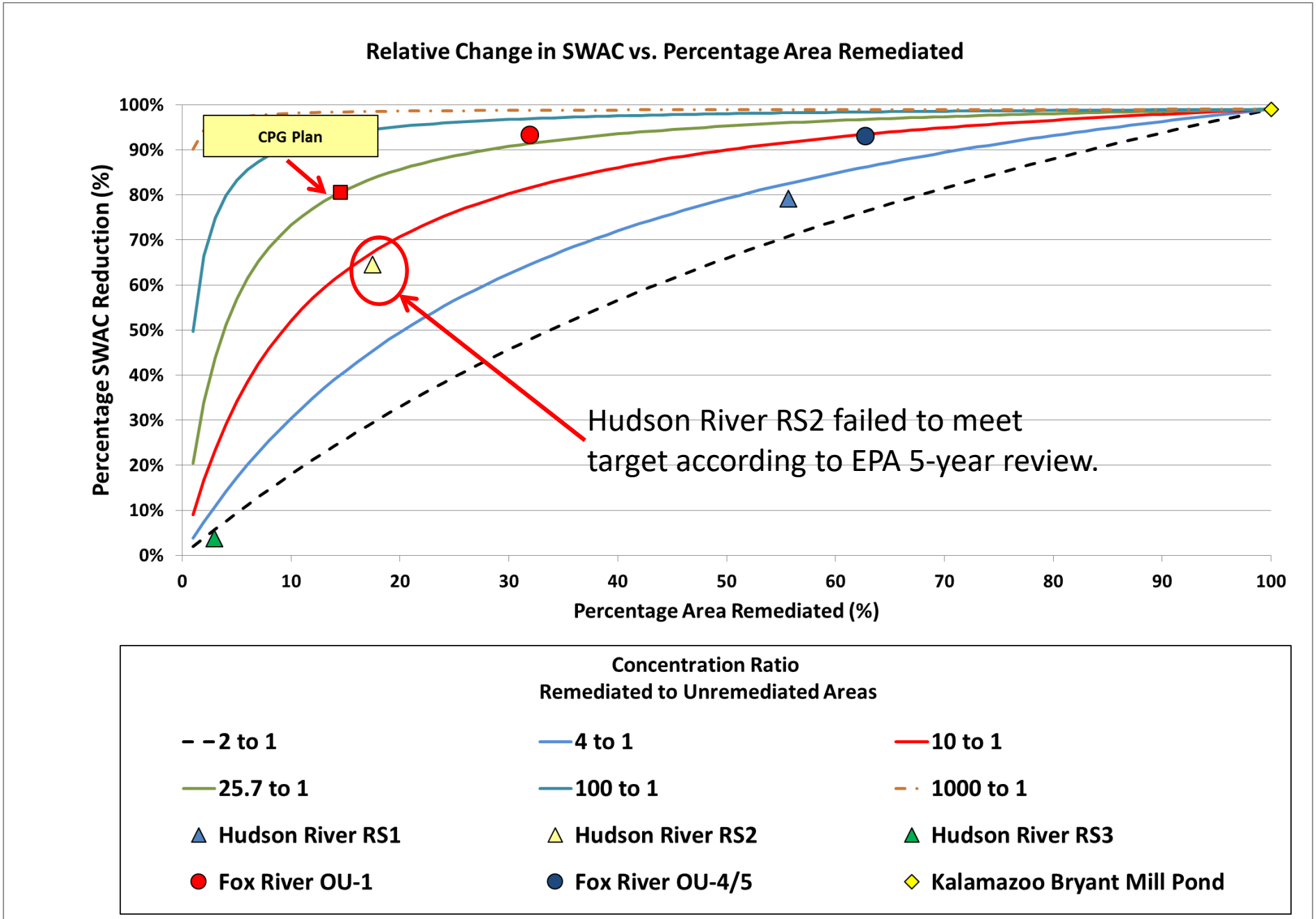
Summary of Point by Point Technical Issues in CPG Response

- Algebraic constraints on remedial performance.
- Usage of RM 10.9 data illustrating behavior of CPGs SWAC vs. RAL Calculation
- Sensitivity of maps to small changes in supporting data
- Use of SSP2 data to validate CPGs model
- Statistical Simulation

26 to 1 Ratio of Target to Nontarget Average Concentrations

Section 3.1.2 (CPG Statement)
The curves shown in Figure 2 of the Region 2 White Paper are of little practical value and are used to incorrectly imply that the ratio of the average concentration in remediated to un-remediated areas is 26:1 throughout the river. That is not the case; approximately half of the target areas have ratios less than 10:1.

- The white paper does not suggest that the ratio *is* 26:1, but rather that to achieve 81% reduction with a 15% remedial footprint the ratio *must be at least* 26:1. Any lower ratio will preclude achieving the CPGs targeted level of reduction.
- The EPA agrees with CPG that achieving a 26:1 ratio is highly unlikely and therefore a substantively larger remedial footprint is necessary to achiever 81% reduction.
- Experience at other sites suggest that achieving 81% reduction would require remediation of 30% to 60% of surface area.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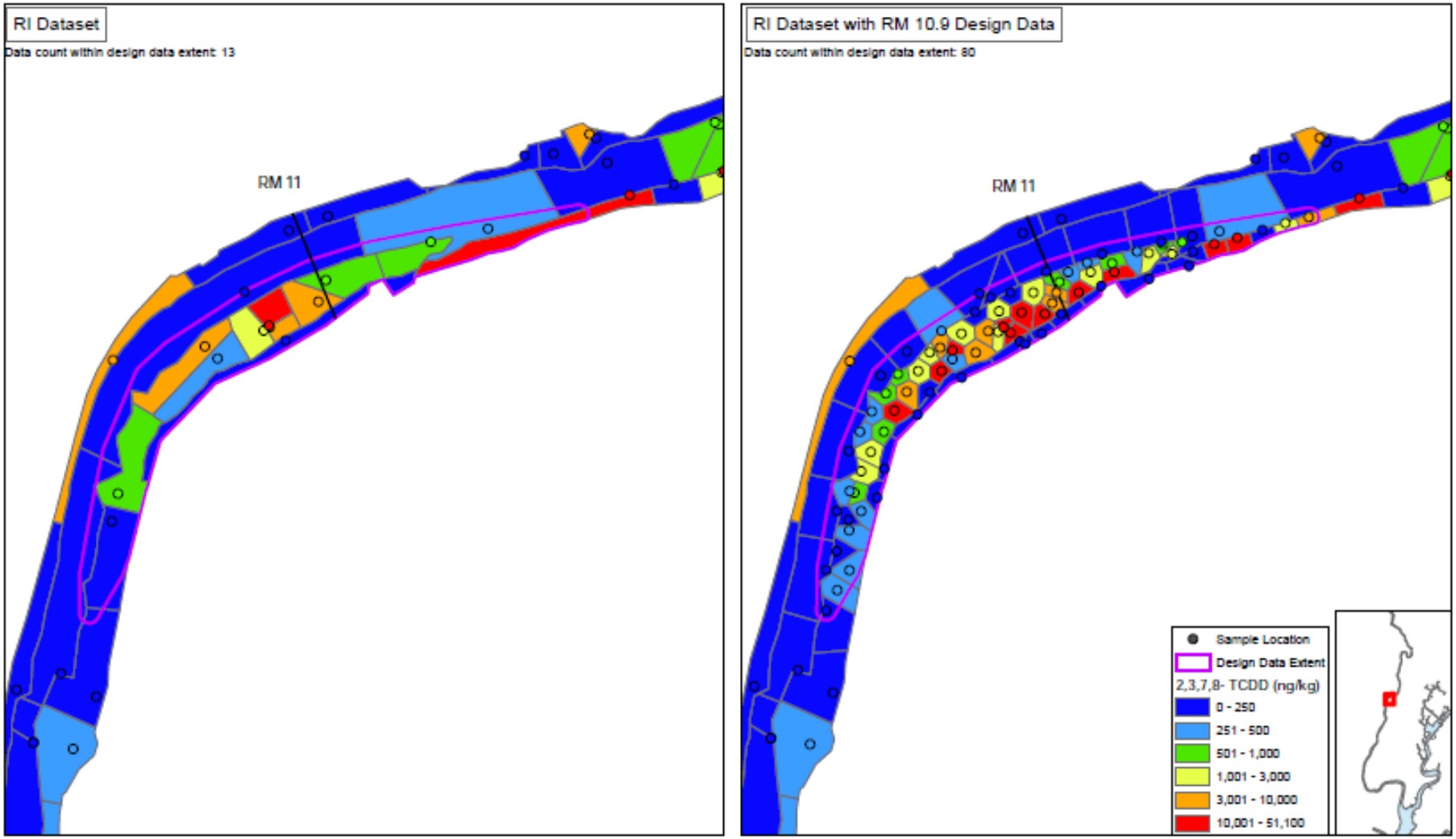
RM 10.9 evaluation of CPGs SWAC vs. RAL Calculation

Section 3.2 (CPG States)
Two aspects of Region 2's test invalidate its conclusions: 1) it considers an area that extends far beyond the region where design scale data exist (Figure 3-4); and 2) it does not test the map presented in the Draft 17-mile RI Report; rather it tests a cruder map generated using only a portion of the RI data.

The analysis should consider only the 13-acre area where high density data were collected.

- EPA analysis evaluated the accuracy of the SWAC vs RAL calculation using RI data density (0.5 samples per acre) in and around RM10.9. This was a test of the CPG calculation procedure.
- The CPGs suggestion to work with the 13 acre design data extent, would provide a test of the mean of N=13 and N=80 samples conditional on a pre-specified area.
- This is not how the CPGs SWAC vs RAL calculation was performed and therefore would not provide a test of the relationship.



0 500 1,000 2,000 Feet

Figure 3-6
Comparison of RI Dataset and RI Dataset with RM 10.9 Design Data Interpolations
Contaminant Mapping Response
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

Sensitivity of Maps to Small Changes in Supporting Data

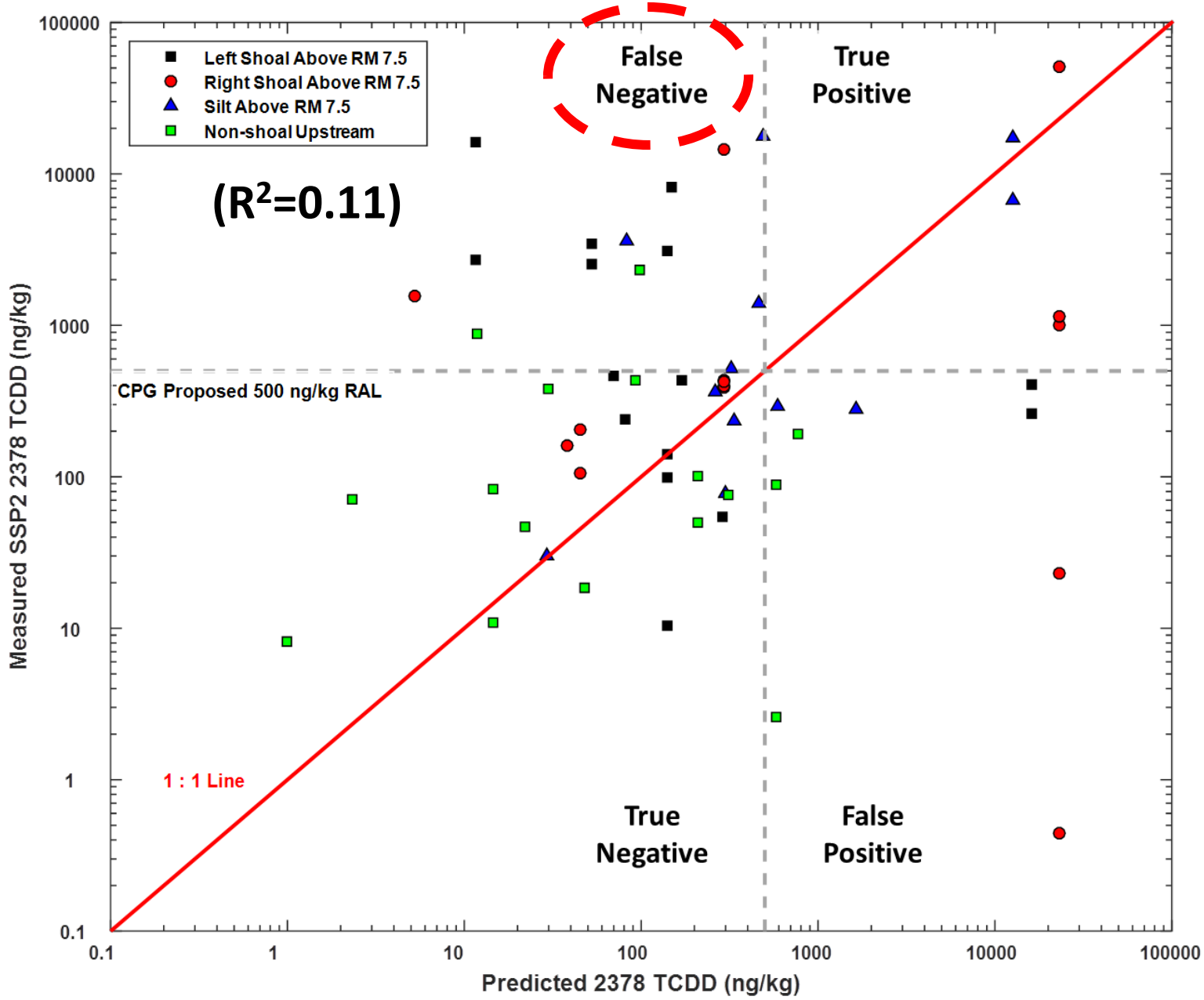
Section 3.3 (CPG States)
In all scientific endeavors, methodology evolves as knowledge is gained. New data and information are used to refine understanding and improve methods. The development of the CPG's mapping approach is no different. Between the 2013 and 2015 mapping, modifications in methodology stemmed from a better understanding of the system and were a response to representations are subject to change as new data and/or insights become available. As the mapping is updated, the delineation of target areas for a given RAL will also shift.

- The RAL vs SWAC relationship is a forecast that requires accurate representation of the percentage composition of surface concentrations.
- The COPC mapping is used to define this percentage composition.
- Sensitive to small changes in mapping rules and data implies the frequency distribution of TCDD is uncertain.
- The CPG has not accounted for this uncertainty in the SWAC vs RAL relationship.
- None of the maps generated by the CPG have been validated with independent data.

Use of SSP2 data to validate CPGs model

Section 3.4 (CPG States)
For example, SSP2 samples were sited to address concern with mapped high concentrations in sediment identified as coarse in side scan sonar. These high concentrations were from finer sediments found within a generally coarse area. Anticipating that they were finer pockets not characteristic of the coarse deposit, samples were collected in SSP2 to bound the extent of elevated concentrations. Therefore, finding lower concentrations is no surprise and consistent with the system understanding. The samples were not collected with the expectation of confirming the high concentration polygon.

- DQO 1 – Provide additional characterization of the nature and extent of sediment chemistry and fill data needs above RM 8, **as identified by USEPA**.
- EPA found more of a problem with higher concentrations where low concentrations were predicted (False Negatives).
- Some samples may have been in areas where prediction is difficult, but one should not expect correlation to be completely absent(R^2=0.11).


Left Shoal Above RM 7.5
Right Shoal Above RM 7.5
Silt Above RM 7.5
Non-shoal Upstream
False Negative
True Positive
(R²=0.11)
CPG Proposed 500 ng/kg RAL
1 : 1 Line
True Negative
False Positive
Measured SSP2 2378 TCDD (ng/kg)
Predicted 2378 TCDD (ng/kg)
100000
10000
1000
100
10
1
0.1
0.1
1
10
100
1000
10000
100000

Statistical Simulation

Section 3.5 (CPG States)

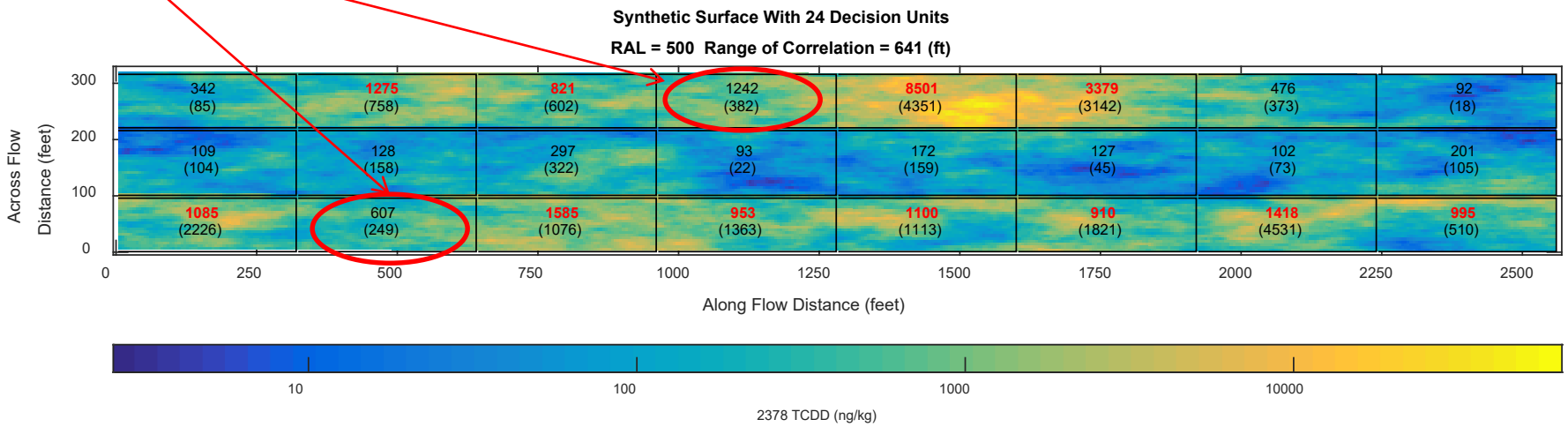
Region 2's statistical simulation ignores the basic characteristic of a targeted remedy by defining target and non-target areas using decision units much greater than the area over which concentrations are correlated, thus including regions of low and high concentrations.

- The simulation follows the CPG SWAC vs RAL calculation identically
- The report included 2 simulation runs with range of influence approximately equal to the distance between adjacent samples (201 feet,) and substantially longer range of influence (320 feet).
- In many areas the distances between nearest RI samples are greater than the range of influence estimated by CPG.
- The simulations were re-run with the rectangular decision units corresponding exactly to the Thiessen polygons as with the CPG procedure, and with range of influence three times the distance between adjacent samples (Much stronger spatial correlation than observed at LPR)
  - Results are not substantively different
  - Reduction in SWAC is overstated
  - Footprint size remains understated

Simulation Results

(Sampling at Centroid of Thiessen Polygon and range of influence 641 ft)

Two False Negatives and no False Positives



Notes:

1) Decision unit average represented by top number: 1085

2) Single sample value shown in parentheses: (2226)

3) Red text indicates cells identified for removal because the sample value exceeds the RAL = 500

Other Sites Discussed by CPG

Precedent at Other Sites:

Table 1-1
Sampling Densities and Interpolation Methods at Several Contaminated Sediment Sites

Site	COPC	Size		RI/FS				Remedial Design				
				Data (for primary COPC)				Pre-remedial Design Data				
				Number of Sampling Locations	Sampling Density (locations per...)		Aerial Interpolation Method	Number of Sampling Locations	Sampling Density (locations per...)		Aerial Interpolation Method
		Miles	Acres		Acre	Mile			Acre	Mile	
Lower Passaic River	2,3,7,8-TCDD, and others	17	1,016	480	0.47	28	River divided into groups and thiessen polygons were used to interpolate within groups	NA			
Portland Harbor	PCBs	10	2,172	1,595	0.73	160	Natural neighbors	NA			
	Dioxans/furans			1,488	0.69	149					
	PAHs			2,040	0.94	204					
	DDx			356	0.16	36					
Buffalo River*	PAH, PCB, Pb, and Hg	8	289	391	1.35	51	IDW	chemical 560	1.9	74	Manual adjustments to FS delineation
								probing 800	3	105	
Upper Hudson River	PCBs	40	4,456	2,303	0.52	58	For RS1 and RS2, the river was divided into cohesive and non-cohesive, thiessen polygons within these areas. Hotspots targeted in RS3.	11,550	~8 – 10 cores in target areas	~290	A combination of IDW, Kriging, and manual delineation
Lower Fox River**	PCBs	39	3,100	900	0.29	23	IDW	3,660	1.6	105	Indicator Kriging with river straightening

Notes:

*For Buffalo River remedial design, chemical and probing data counts are shown separately. Probing was done to determine depth to till.

**For ease of comparison, only the Lower Fox River data used in the mapping to establish target areas in the river (not in Green Bay) are summarized (i.e., OU1 to OU4). Acreage is the estimated acreage of river bottom that had sediment deposits and consequently would have been amenable to sediment sampling. The remedial design data summary does not include OU1 and therefore is summarized for the lower 35 miles of river, which includes 2,326 acres of sediment.

2,3,7,8,-TCDD = 2,3,7,8-tetrachlorodibenzo-p-dioxin
COPC = chemical of potential concern
FS = Feasibility Study
Hg = Mercury
IDW = Inverse Distance Weighted
NA = not applicable
PAH = polycyclic aromatic hydrocarbon
Pb = Lead
PCB = polychlorinated biphenyl
RI = Remedial Investigation
RS = river section

Additional Examples not Mentioned

- Kalamazoo River (RI/FS data)
  - Area 4 Trowbridge Impoundment
  - N=739 Area=448 (**1.6 Locations per acre**)
- Plainwell Impoundment
  - N~=350 Area=64 Acres (**5.5 Locations per acre**)
- Bryant Mill Pond
  - N=132 Area=29 Acres (**4.6 Locations Per acre**)
- Lower Duwamish Waterway:
  - N=1248 Area=428 Acres (**2.9 samples per acre**)
- Fox River: (Rod Reopened in part due to inability to meet predicted post remedial SWAC)
  - OU2-5; N~=3,000 (Design Samples)

Excerpt from Fox River ROD amendment (Reopened in part due to inaccurate SWAC v RAL)

The Fox River ROD was reopened in part because of unexpected inventory revealed after the RI/FS and because of unexpected moderate concentrations outside the remedial footprint that would preclude meeting the SWAC target with the 1ppm RAL which was calculated based on RI/FS data using calculation similar to that proposed by CPG.

Excerpt from the 2007 ROD Amendment:

In addition to identifying a larger volume of sediment that would need to be removed under the 2003 ROD, the additional sampling and analyses performed during the remedial design process showed that the 2003 ROD dredging remedy alone probably could not meet the PCB SWAC goals outlined in the 2003 ROD (i.e., 0.26 ppm for OU 3 and 0.25 ppm for OU 4). There are two main reasons why the 2003 ROD remedy would be unlikely to meet those SWAC goals.

• First, even if all sediment exceeding the 1.0 ppm PCB RAL is dredged in an area, the post-dredging surface concentrations may still exceed 1.0 ppm PCBs. That is because experience with dredging projects at this Site and elsewhere has shown that the dredging process itself commonly re-suspends some contaminated sediment that is then re-deposited in a thin layer on top of the newly-dredged area. That re-deposited contamination is called "generated residuals."1 The 2003 ROD indicated that generated residuals could be addressed by re-dredging and/or placement of sand covers over dredged areas, but recent experience suggests that generated residuals could still increase the SWAC calculation even if those residuals management approaches were employed.

• Second, contrary to earlier expectations, the recent sampling data shows that large areas of relatively low PCB levels on the surface of undredged areas (i.e., in areas with no sediment exceeding the 1.0 ppm PCB RAL) might prevent the 2003 ROD remedy from reaching the OU-wide SWAC goals.

Design Sampling Expectations

Review of GE's February 28, 2005 Phase 1 Dredge Area Delineation Report

March 9, 2005

Malcolm Pirnie, Inc.

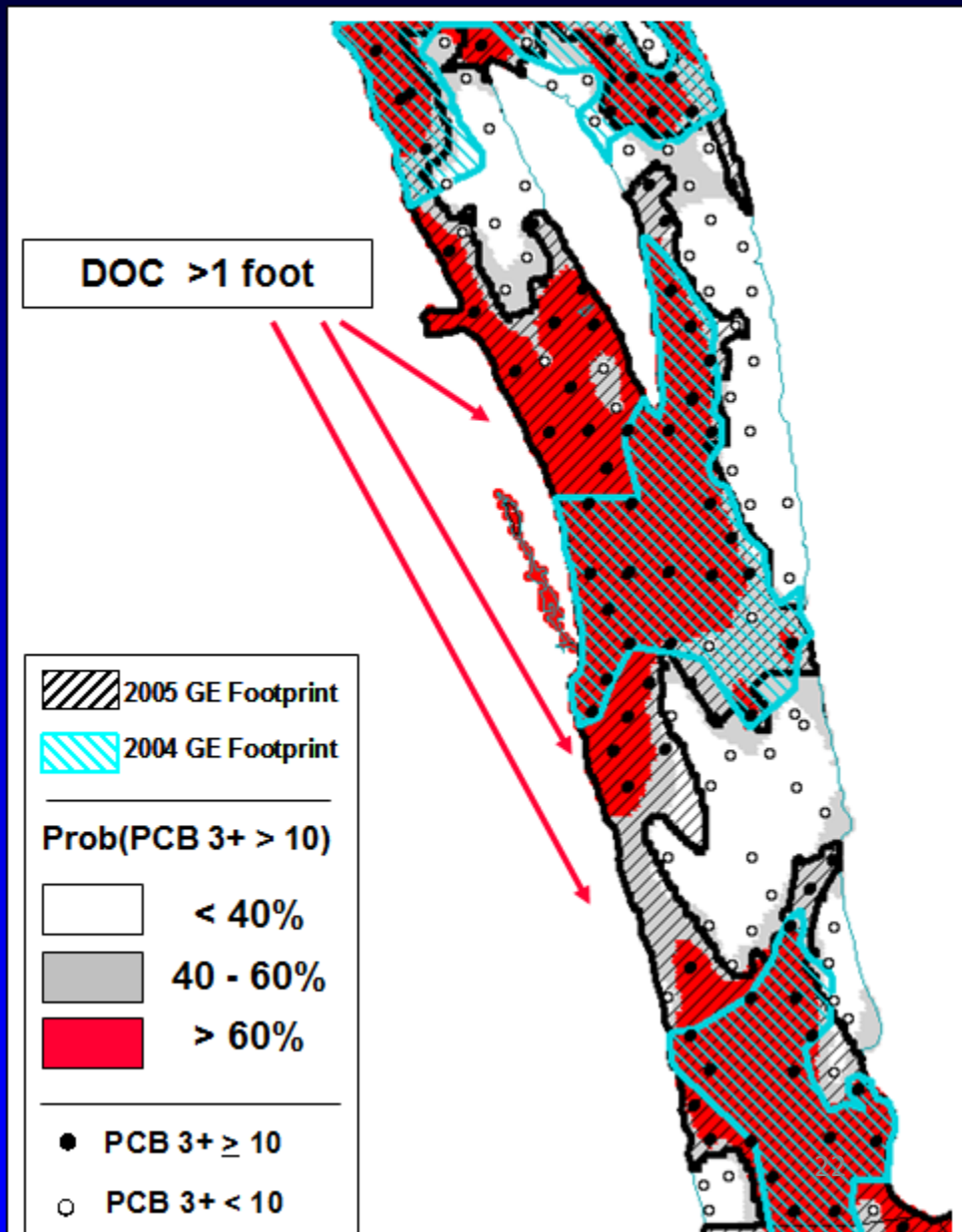
TAMS, *an EarthTech Company*

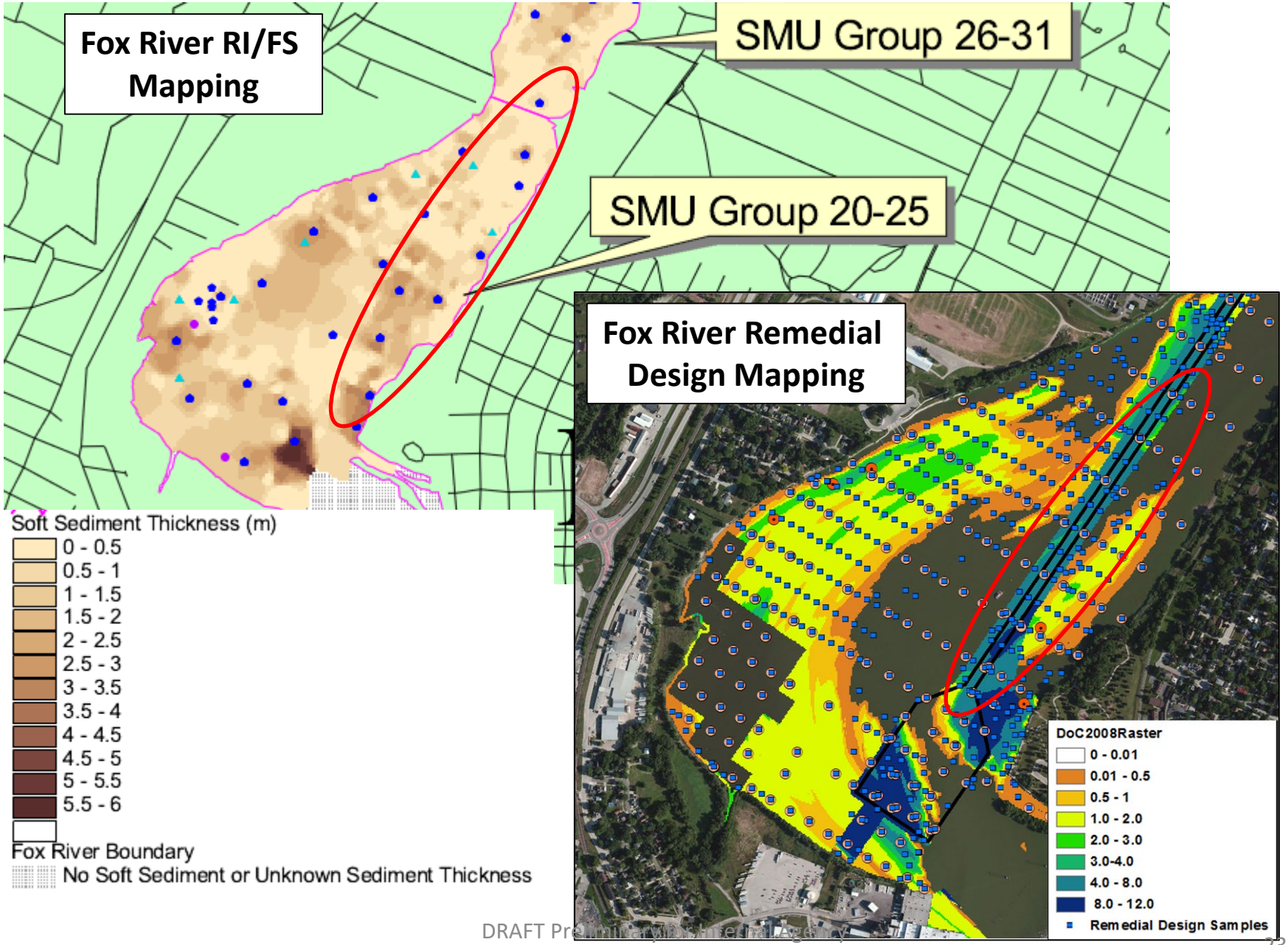
Kern Statistical Services, Inc.

Hudson River PCBs SUPERFUND SITE

Change in Lateral Extent

- Increased lateral footprint due to data gap sampling.
- Contaminated sediments in previously unidentified areas areas are over a foot thick.
- Data gap sampling in Phase II areas may reveal similar results.




Fox River RI/FS Mapping
SMU Group 26-31
SMU Group 20-25
Fox River Remedial Design Mapping
Soft Sediment Thickness (m)
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 2.5
2.5 - 3
3 - 3.5
3.5 - 4
4 - 4.5
4.5 - 5
5 - 5.5
5.5 - 6
Fox River Boundary
No Soft Sediment or Unknown Sediment Thickness
DoC2008Raster
0 - 0.01
0.01 - 0.5
0.5 - 1
1.0 - 2.0
2.0 - 3.0
3.0-4.0
4.0 - 8.0
8.0 - 12.0
Remedial Design Samples

Lower Duwamish Waterway Group

Port of Seattle / City of Seattle / King County / The Boeing Company

Appendix H
Coverage Rates for Selected Upper Confidence Limit Methods for Mean of Total PCB in Sediments

Final Feasibility Study

Lower Duwamish Waterway
Seattle, Washington

Appendix H: Coverage Rates for Selected Upper Confidence Limit Methods for Mean of Total PCB in Sediments

Table 2. Summary of coverage rates for 5 UCL methods for reaches 1, 2 and 3 and the full LDW study area. Stratified approaches were based on the two stratum configuration.

	Halls Interp	Bootstrap T Interpolated	Bootstrap T Stratified	Balanced Bootstrap Thiessen	Balanced Bootstrap Stratified
Reach 1	90%	89%	92%	93%	94%
Reach 2	100%	100%	96%	97%	98%
Reach 3	91%	91%	88%	97%	92%
Full Site	100%	100%	87%	99%	95%

- Most accurate method was based on stratified sampling formulas
- Two stratum approach better than 11 stratum case.
- Methods based on interpolation performed poorly.

Lower Duwamish Waterway RI/FS
(N=1300 Sampling Locations)